Program Information								
	[Lesson Title] ***Deficiencies and Megadoses***			**TEACHER NAME**		**PROGRAM NAME**	
	[Unit Title] ***Algebra and Patterns***			**NRS EFL(s)** **3 – 6**		**TIME FRAME** **120 minutes**	

Instruction

ABE/ASE Standards – Mathematics

Numbers (N)		Algebra (A)		Geometry (G)		Data (D)	
Numbers and Operation	**N.3.26** **N.3.19**	Operations and Algebraic Thinking		Geometric Shapes and Figures		Measurement and Data	
The Number System		Expressions and Equations	**A.3.8** **A.4.3**	Congruence		Statistics and Probability	
Ratios and Proportional Relationships		Functions	**A.4.13** **A.6.6** **A.4.15** **A.6.9**	Similarity, Right Triangles. And Trigonometry		**Benchmarks identified in *RED* are priority be benchmarks. To view a complete list of priority benchmarks and related Ohio ABLE lesson plans, please see the Curriculum Alignments located on the Teacher Resource Center (TRC).**	
Number and Quantity				Geometric Measurement and Dimensions			
				Modeling with Geometry			

Mathematical Practices (MP)			
☐	Make sense of problems and persevere in solving them. (MP.1)	☐	Use appropriate tools strategically. (MP51)
☐	Reason abstractly and quantitatively. (MP.2)	☐	Attend to precision. (MP.6)
☐	Construct viable arguments and critique the reasoning of others. (MP.3)	☐	Look for and make use of structure. (MP.7)
☐	Model with mathematics. (MP.4)	☐	Look for and express regularity in repeated reasoning. (MP.8)

LEARNER OUTCOME(S)

- Given a lower bound, an upper bound, and dosage amounts for two variables, students will construct an algebraic inequality to represent the relationship between the variables and the bounds.
- Students will then solve this inequality and graph it on the XY plane.

ASSESSMENT TOOLS/METHODS

- Steps 8 and 9 will serve as evidence of student mastery.
  - During Step 8, the teacher should actively listen to partner discussions for signs of understanding or of misconceptions. If students are working alone, the teacher should have students speak out loud as they solve the problem.
  - During Step 9, allow students the opportunity to modify their solutions based on what they learn from watching others present their solutions.
- Exit Slip: For Vitamin C, the RDA is 90 mg and the TUIL is 2000 mg. A popular energy drink contains 1000 mg of Vitamin C, and a serving of broccoli contains 90 mg. 1. Write an inequality for the number of energy drinks and broccoli servings you could have to stay between the RDA and TUIL. 2. Graph the inequality.

LEARNER PRIOR KNOWLEDGE

- Students should know how to convert between units and be familiar with the number line.
- Students should also know how to solve algebraic equations.

	INSTRUCTIONAL ACTIVITIES	RESOURCES
	1. Review (or introduce) the concept of scientific notation. Review basic number line problems such as $3 \leq x \leq 6$ and $3 \leq x < 6$, making sure to emphasize the difference between an open dot (< or >) and a closed dot (≤ or ≥). 2. Go over systems of equations. Start with a simple example like $x + y = 4$, $x – y = 2$ and then move onto more challenging examples. Present the substitution method (solve for x or y in one equation and then plug it into the other equation) and the synthesis method (multiply one or both equations so that a variable has opposite coefficients and then add the equations). For example, using the synthesis method to solve $2x + 3y = 7$, $5x - 2y = -1.5$, you could multiply the first equation by 5 and the second equation by -2 and then add the two equations to get $19y = 38$. Thus, $y=2$ and $x = (1/2)$. After you solve the system, plot both lines on the X-Y plane and ask what the intersection represents (it should be the point (1/2, 2) that you just found). 3. Keep the same two original equations on the board, but change the equals signs into greater than or equals. (e.g., $2x + 3y \geq 7$, $5x - 2y \geq -1.5$). Ask if anyone has any ideas on solving this new system of equations. Show how you can solve for either x or y in each equation and then shade above (y is greater than), below (y is less than), to the left (x is less than), or to the right (x is greater than) of the line. If BOTH equations must be satisfied, then the answer will be the region of the X-Y plane that is shaded twice. Discuss how this means that the answer is a region instead of a point like in Step 2. 4. Put the following problem on the board: $3 \leq 2x + 5y \leq 7$. Ask for ideas on how students would approach this problem. Show how this can be broken up into two inequalities ($3 \leq 2x + 5y$ and $2x + 5y$	Student copies of *Vitamin D* handout (attached) Student copies of *Vitamin E* handout (attached) Student copies of *Folic Acid* handout (attached) *Teacher Answer Sheet* (attached) Vocabulary Sheet (attached)

	≤ 7) and then solved as in Step 3. Make sure you plot this on a graph. Ask students to list at least one integer pair solution in the shaded region (e.g., (0,1)). 5. Introduce the context. Tell your students about the general concept of deficiencies and megadoses (basically that our bodies are sensitive to too much and too little of many important vitamins and minerals). This can get complicated because a vitamin can be present in different forms, each of which may have a distinct potency level. Explain that scientists have derived a measurement unit named IU (International Unit) to handle this problem. The lower limit of IU of a particular vitamin or mineral that nutritionists recommend for each person is the Recommended Daily Allowance (RDA). The upper limit considered to be safe is the Tolerable Upper Intake Limit (TUIL). Tell students that the contents of this lesson are based on the most accurate information available, but that that this lesson does not take the place of official medical advice. Certain people have health conditions that will require taking less than the RDA or more than the TUIL of a vitamin and so students should consult their doctor before making any changes to their diet. 6. (I do) Teacher models the solution process on the *Vitamin D* handout. Spend a few minutes becoming familiar with *Vitamin D* as a group before going through the task questions. Use the Talk Aloud procedure as you work through each of the first four questions. (Option for advanced groups: When you create the number line for Question #2, create and label intermediate places on the line also. For example, the IU side of the line could be labeled at every 1,000 IU, and then the microgram side would be labeled at every 25 micrograms). 7. (We do) Teacher and students collaboratively work through the *Vitamin E* task. Begin with the *Vitamin E* source chart and discuss whether students are eating natural sources of Vitamin E. Then	

	read through the benefits, as well as the dangers of deficiency and megadoses. When you get to the conversions, this will be the first time most of the students will have encountered a split conversion. Remind students that this is why most nutrition labels use IU for vitamins and minerals instead of a standard weight (in other words, the IU give us a single measure for comparing different sources of Vitamin E with different potency levels). Questions #1 and #2 are very similar to what students watched you do in the *Vitamin D* task, so try to see if they can handle these steps (with the help of your prompts when necessary). As you are talking through Questions #3 and #4, make sure you point out that #3 is an equation and #4 is an inequality. For #4, make sure you work through a 2-variable inequality (in other words, consider the two together instead of separately – see the *Teacher Answer Sheet* for an example of this). 8. (You do) Students independently work through the *Folic Acid* handout. Depending on your class dynamics, either partner students together or have them work individually. Before you pass out the task, explain that you want the students to tackle this problem as independently as possible. After passing out the handouts, walk around the room silently monitoring the students' progress. When you see them run into difficulties, try not to answer their questions directly; instead, remind them of similar situations from the first two tasks. Question #4 is the most difficult. Refer them to go back through Question #4 from the *Vitamin E* task before prompting them with answers. 9. Have each student (or pair) share both the process they used and their final comparisons. Encourage students to discuss the pros and cons of alternative approaches taken. In this case, there is only one correct answer for each question, although students may have different representations for #4. When students disagree, do not immediately provide the correct answer; allow each student or pair to try to convince the other first.	

	10. Making it relevant. Have students brainstorm specific vitamins or minerals that they want to investigate in their diet (see “Next Steps” below for an optional assignment).	
	DIFFERENTIATION	
Reflection	**TEACHER REFLECTION/LESSON EVALUATION**	

	ADDITIONAL INFORMATION **NEXT STEPS** If students take any supplements, have them research the RDA and TUIL for each one, and then estimate their average daily intake. If they are not already taking supplements, have them research a common one like Vitamin C or Calcium and see how their natural daily intake compares to the desirable range. See websites below for research starting points. **TECHNOLOGY INTEGRATION** This article provides a more thorough discussion about the concept of deficiencies and megadoses: http://www.arthritistoday.org/nutrition-and-weight-loss/vitamin-and-mineral-guide/too-many-vitamins-minerals.php The Mayo Clinic is one of the most reputable sources of health information in the world. This following link takes students to the Vitamin E information page, but they can easily search for other vitamins or minerals in the search box: http://www.mayoclinic.com/health/vitamin-e/NS_patient-vitamine/DSECTION=dosing **PURPOSEFUL/TRANSPARENT** Students are concerned about their health, but do not (and should not) always trust the messages they are given about how much vitamins they need. In this lesson, students learn to calculate appropriate vitamin dosages by using algebraic inequalities. **CONTEXTUAL** This lesson hits on dosages of vitamins and minerals, one of the few topics applicable to everyone's life. The issue becomes even more important given the ubiquitous presence of energy drinks, energy bars, fortified foods, and supplements. **BUILDING EXPERTISE** This lesson builds on students' ability to read a number line, understand a simple inequality, and solve a basic system of equations. Students must combine these three skills to solve systems of inequalities. The final step of plotting the graphs forges connections between algebraic and graphical representations.

NOTE: The content in the Additional Information box exceeds what is required for the OBR Approved Lesson Plan Template. This information was provided during the initial development of the lesson, prior to the creation of the OBR Approved Lesson Plan Template. Feel free to remove from or add to the Additional Information box to suit your lesson planning needs.

Deficiencies and Megadoses: Vocabulary Sheet

Algebraic equation – an equation that includes at least one unknown variable.

Deficiency – a problematic condition where the body is not receiving an adequate amount of a specific vitamin or mineral.

Integer pair – a coordinate on the X-Y plane, where both the x-value and y-value are integers. For example (2, -7) would be an integer pair, but (0.5, 3) would not.

Megadose – a problematic condition where the body is receiving too much of a specific vitamin or mineral.

Number line – a line on which each point represents a real number.

Scientific notation – a numeric format where the base number, which is greater than or equal to one and less than 10, is multiplied times a power of ten.

System of equations – a set of at least two algebraic equations with the same value for each variable.

Vitamin D

Deficiencies and Megadoses

Sources: Fish, fortified milk, eggs, sunlight

Potential Benefits: Calcium absorption, bone growth, bone healing, helps prevent osteoporosis, may help fight cancer and reduce high blood pressure , regulate calcium and phosphorus in the blood

Dangers of Deficiency: Rickets (deformities in the skeleton), osteomalacia (weakness of muscles and bones), increased heart attacks

Dangers of Megadose: Increased risk of fractures, urinary tract infections, and cancer. One study reported increased daytime sleepiness.

Tolerable Upper Intake Limit (ages 19-70): 4,000 IU

Recommended Daily Allowance (ages 19-70): 600 IU

Conversions: 1 IU = 2.5×10^{-5} mg of cholecalciferol

Vitamin D Task

1. Using the information provided on this page, calculate the desirable range of Vitamin D intake (in µg, mg, and IU) for an adult. Write all of your answers in scientific notation with 2 significant digits.
2. Create a single number line, labeled in µg and IU, and shade in the desirable range of Vitamin D intake.
3. Based on your number line, evaluate the three supplements on the right. Which one would you prefer to take? Why?
4. If your only other source of Vitamin D in winter is milk (400 IU per quart), how many quarts would you need to drink in addition to your chosen supplement to reach 70% of the TUIL? Graph this equality.

Supplement #1

Supplement #2

Supplement #3

Vitamin E

Deficiencies and Megadoses

Sources: Corn, nuts, eggs, olives, sunflower seeds, leafy greens

Potential Benefits: Tentative results suggest Vitamin E may help prevent cancer or slow dementia

Dangers of Deficiency: None, except for individuals with certain conditions (Crohn's or cystic fibrosis)

Dangers of Megadose: Slight increased risk of death from all causes. Increased risk of heart failure, stroke, and may cause vision to decline more rapidly.

Tolerable Upper Intake Limit: 1500 IU

Recommended Daily Allowance: 22.5 IU

Conversions: 1.5 IU = 1.0×10^3 µg of d-alpha-tocopherol (DAT)

1 IU = 1.0×10^3 µg of dl-alpha-tocopherol acetate (DLATA)

Supplement #1

Supplement #2

Vitamin E Task

1. Using the information provided on this page, calculate the desirable range of Vitamin E intake (in IU, mg of DAT, and mg of DLATA) for an adult. Write all of your answers in scientific notation with 2 significant digits.
2. Create a single number line, labeled in mg of DAT and IU, and shade in the desirable range of calcium intake.
3. How many Tbs of peanut butter would equal the same IU of Vitamin E in 1 serving of Supplement #1?
4. Choose one of the supplements and one of the food sources and write an inequality for the combination you could have to stay above the RDA *and* under the TUIL. Graph this inequality.

Vitamin E Source Chart

Table 2: Selected Food Sources of Vitamin E (Alpha-Tocopherol) [7]

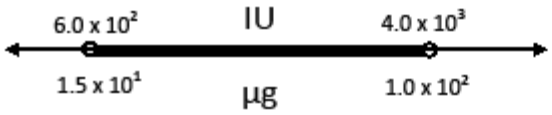
Food	Milligrams (mg) per serving	Percent DV*
Wheat germ oil, 1 tablespoon	20.3	100
Sunflower seeds, dry roasted, 1 ounce	7.4	37
Almonds, dry roasted, 1 ounce	6.8	34
Sunflower oil, 1 tablespoon	5.6	28
Safflower oil, 1 tablespoon	4.6	23
Hazelnuts, dry roasted, 1 ounce	4.3	22
Peanut butter, 2 tablespoons	2.9	15
Peanuts, dry roasted, 1 ounce	2.2	11
Corn oil, 1 tablespoon	1.9	10

Deficiencies and Megadoses: Teacher Answer Sheet

Vitamin D Task

1. 1.5×10^{-2} mg < x < 1.0×10^{-1} mg , 1.5×10^{1} µg < x < 1.0×10^{2} µg , 6.0×10^{2} IU < x < 4.0×10^{3}

2.



3. Answers may vary.

4. 70% of TUIL = .7 * 4000 = 2800 IU, Let x = serving of Supplement #2, y = quarts of milk.

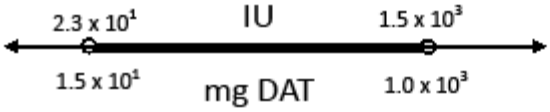
1000x + 400y = 2800 which reduces to 10x + 4y = 28. See graph at right (notice that answers below 0 do not make sense in this context).

Vitamin E Task

1. 1.5×10^{1} mg DAT < x < 1.0×10^{3} mg DAT, 2.3×10^{1} mg DLATA < x < 1.5×10^{3} mg DLATA,

   2.3×10^{1} IU < x < 1.5×10^{3} IU

2.



3. Since there are 200 IU in Supplement #1, and 2 Tbs of peanut butter contain 2.9 mg DAT, we have:

200 IU x (1 mg DAT/1.5 IU) x (2 Tbs/2.9 mg DAT) = about 92 Tbs of peanut butter.

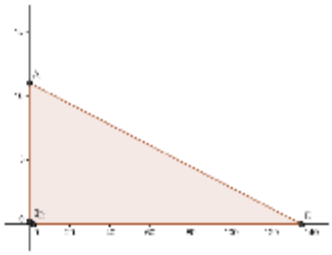
4. As an example, if we choose sunflower seeds (x) and Supplement #2 (y)

22.5 < 11.1x + 136y < 1500 is shown at right.

This is the graph of the lines 22.5 = 11.1x + 136y and

1500 = 11.1x + 136y, but with no negative numbers allowed.

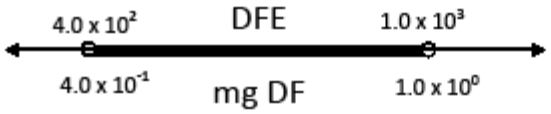
This is a good example to show how it can be useful to let the X and Y axes have different units.



1. 4.0×10^2 µg DF < x < 1.0×10^3 µg DF, 2.4×10^2 µg FAS < x < 9.0×10^2 µg FAS,

   4.0×10^2 DFE < x < 1.0×10^3 DFE

2.



3. 100 DFE per serving of rice, 400 DFE per serving of Supplement #1, so 100x = 400, x=4

4. Letting x = servings of rice and y = servings of the supplement, we have:

400< 100x + 400y < 1000

Folic Acid*

Deficiencies and Megadoses

* Folic acid is also called B9 and occurs naturally in the body as folate. Instead of IU, it uses a similar type of unit known as DFE.

Sources: Egg yolks, fortified white rice, fortified cereal, strawberries, oranges, cauliflower

Potential Benefits: May reduce risk of stroke, helps prevent neural tube defects in fetuses

Dangers of Deficiency: Diarrhea, shortness of breath, nerve damage

Dangers of Megadose: Bloating, cramps, increased cancer risk

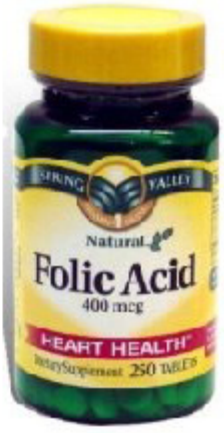
Tolerable Upper Intake Limit: 1,000 DFE (Dietary Folate Equivalent)

Recommended Daily Allowance: 400 DFE

Conversions: 1 DFE = 1.0×10^{-3} mg of dietary folate (DF)

1 DFE = 0.6 mcg (µg) of folic acid supplement (FAS)

Supplement #1



Folic Acid Task

1. Using the information provided on this page, calculate the desirable range of folic acid intake (in DFE, mcg of DF, and mcg of FAS) for an adult. Write all of your answers in scientific notation with 2 significant digits.
2. Create a single number line, labeled in mg DF and DFE, and shade in the desirable range of calcium intake.
3. How many servings of rice (see nutrition label) would it take to get the same DFE of folic acid as Supplement #1 provides?
4. If your only source of dietary folate was rice, how many servings of rice and how many servings of folic acid, combined, would keep you between the RDA and TUIL? Graph your solution.

Rice Nutrition Label

Nutrition Facts

Serving Size 1/4 cup dry (45g)
Servings Per Container About 54

Amount Per Serving

Vitamin A	0%	Vitamin C	0%
Calcium	2%	Iron	10%
Thiamin	15%	Niacin	10%
Folate	25%		

*Percent Daily Values are based on a 2,000 calorie diet. Your daily values might be higher or lower depending on your calorie needs: